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Title: NCERC Capabilites

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# NCERC Capabilities

Joetta Goda, NEN-2

May 12, 2021



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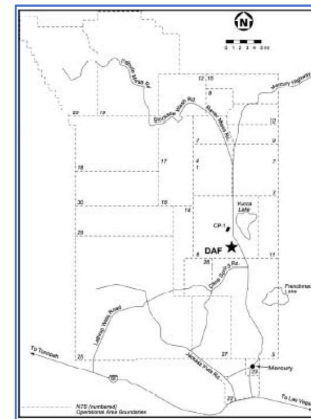
**NCERC is our nation's only general-purpose critical experiments facility and is one of only a few that remain operational throughout the world**

**Location: Device Assembly Facility (DAF) at the Nevada Nuclear Security Site (NNSS)**

**Operated by: Los Alamos National Laboratory**

**NCERC Mission Statement:**

The mission of the National Criticality Experiments Research Center (NCERC) is to conduct experiments and training with critical assemblies and fissionable material at or near criticality in order to explore reactivity phenomena, and to operate the assemblies in the regions from subcritical through delayed critical. One critical assembly, Godiva-IV, is designed to operate above prompt critical.



**There are four critical assembly machines located in two assembly cell buildings.**



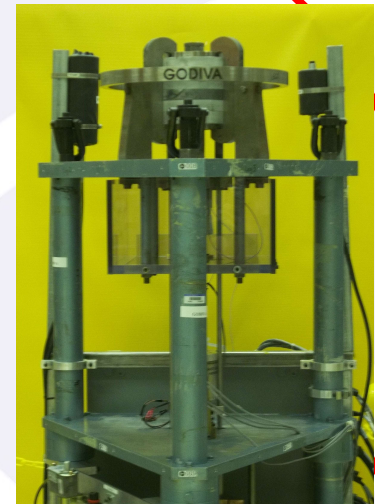
**Planet**



**Flat-Top**



**Comet**



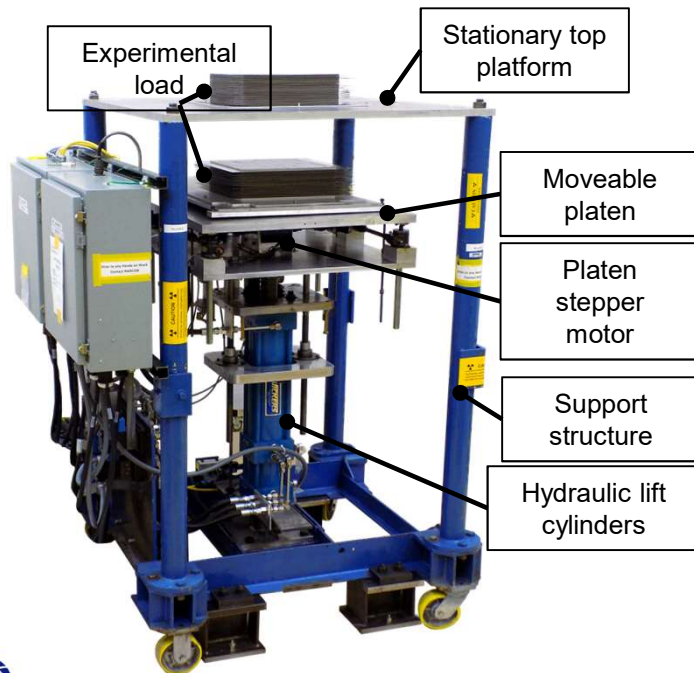
**Godiva IV**



Can only operate one per building at a time.

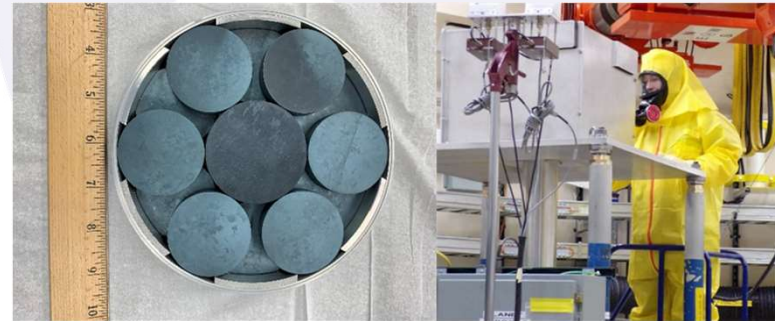
# Planet

**A general-purpose, light-duty vertical-lift assembly designed for flexibility in conducting critical experiments.**



- Criticality Safety Training
- International Criticality Experiments Benchmark Evaluation Project
- NTNF irradiations

MUSIC: subcritical and critical configurations.



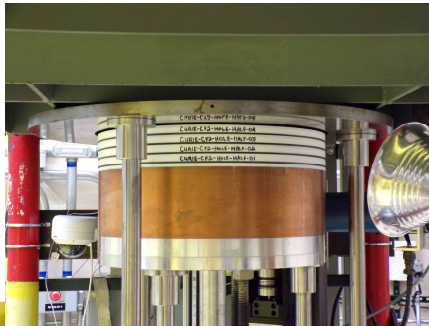
Yttrium Hydride before canning and the Hypatia experiment on Planet for DOE-NE.



Image editing courtesy of Eloura Phelps, NCERC-FO

# Comet

A general-purpose, *heavy-duty* vertical lift assembly designed for flexibility in conducting critical experiments.

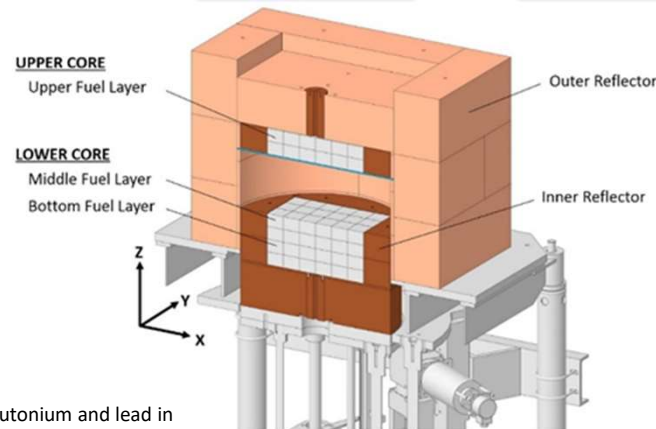


CURIE: Uranium and Teflon to test unresolved resonance region.

- JAEA U-Lead and Pu-Lead
- NASA KRUSTY/Kilopower
- NTNF foil irradiations
- ICSBEP Benchmark Evaluations



TEX-HEU: Uranium and poly, designed to add Hafnium.



Jupiter: Plutonium and lead in collaboration with NA-23 and JAEA.

KRUSTY collaboration with NASA



# Flattop

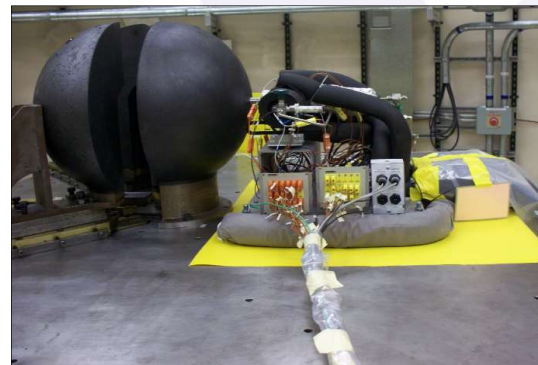
**A fast spectrum benchmark critical assembly designed to demonstrate fundamentals of reactor physics and used as a general-purpose radiation source**

1000 kg natural uranium reflector

500 kg hemisphere and two 250 kg quarter-sphere safety blocks

Interchangeable U-235 and Pu-239 cores

Glory hole for mass adjustment, samples, activation foils, etc.



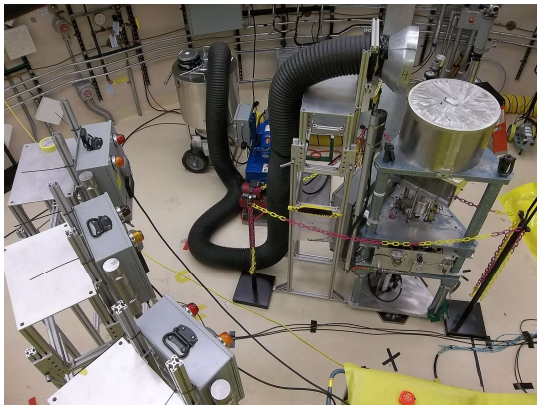
- Criticality Safety Training
- Nuclear Forensics
- Irradiations
- NASA DUFF
- Sample replacement measurements



## Godiva IV

**A critical assembly designed to operate above prompt-critical to provide intense, short bursts of neutrons.**

- Cylindrical 65 kg, 93% enriched uranium, alloyed with 1.5% Mo for strength
- Criticality Safety Training
- Dosimetry Intercomparison
- Criticality Alarm Testing
- Multi-physics measurements



Y-12 Criticality Accident Alarm Systems (CAAS) around Godiva

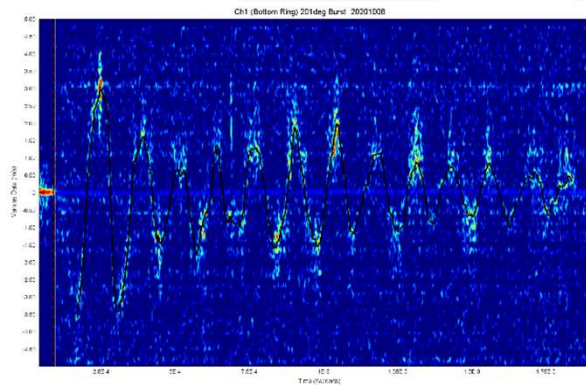
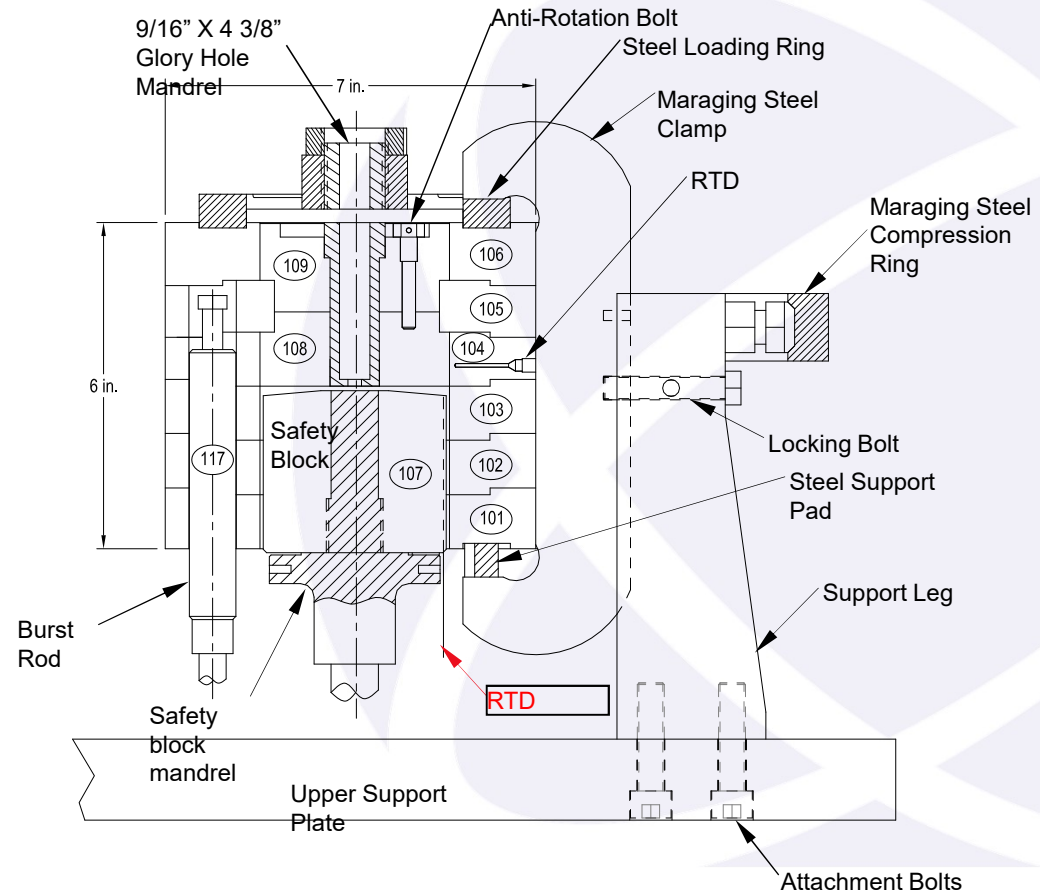


Photo-Doppler Velocimetry response on fuel surface during Godiva burst.



# Godiva Schematic

Bursts referred to by temperature rise in the safety block, near center of assembly

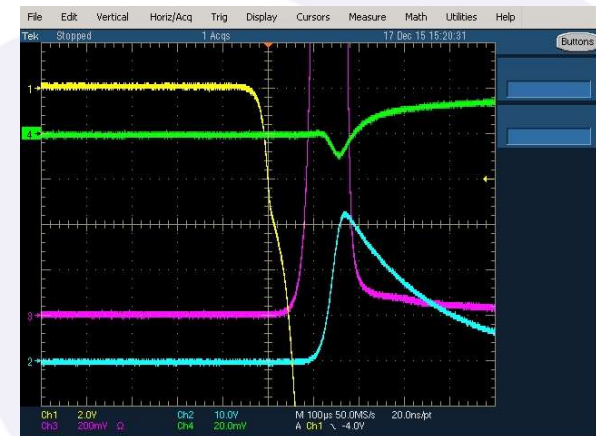


# Burst Sizes

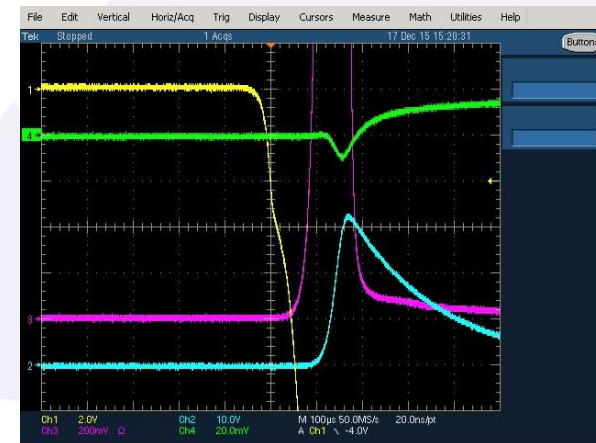
Delta T (C)	70 degree	150 degree	250 degree
Reactivity	\$1.04	\$1.07	\$1.10
Initial Period	30 $\mu$ sec	18 $\mu$ sec	11 $\mu$ sec
alpha	33000/sec	55000/sec	91000/sec
FWHM	100 $\mu$ sec	55 $\mu$ sec	33 $\mu$ sec
# fissions	1 E 16	2 E 16	4 E 16

Initial period measured by PMT (yellow)

FWHM measured by PD (magenta)



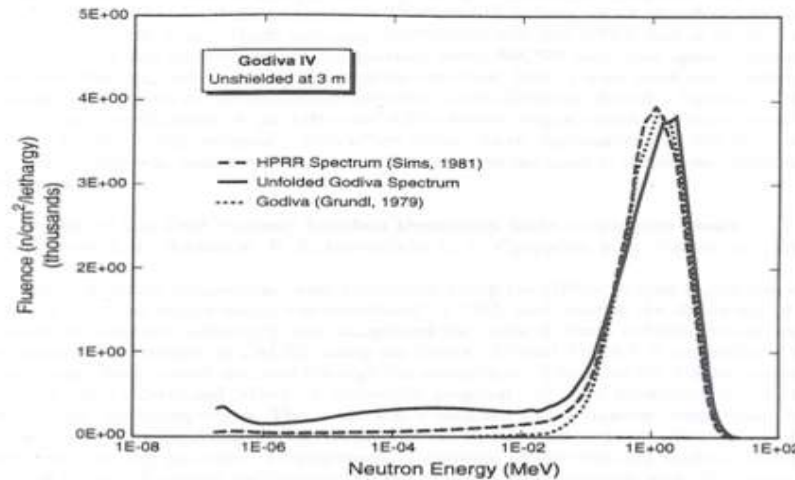
150° Burst



250° Burst



# Radiation Output



Spectrum measured at TA-18, Casson, et al. (1995)

## Achievable with 250°C burst\*

Number of fissions  $\sim 4 \times 10^{16}$

Leakage fluence  $\sim 4 \times 10^{13}$  n/cm<sup>2</sup>

Peak flux  $\sim 10^{18}$  n/cm<sup>2</sup>·s

Rossi-alpha 0.85 E6 1/s

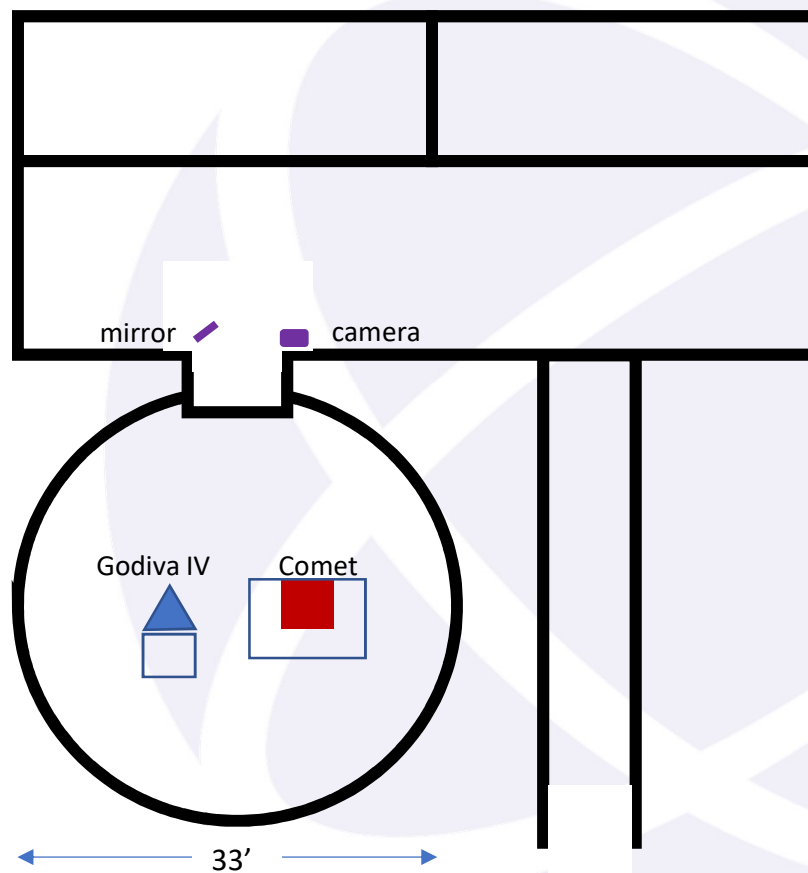
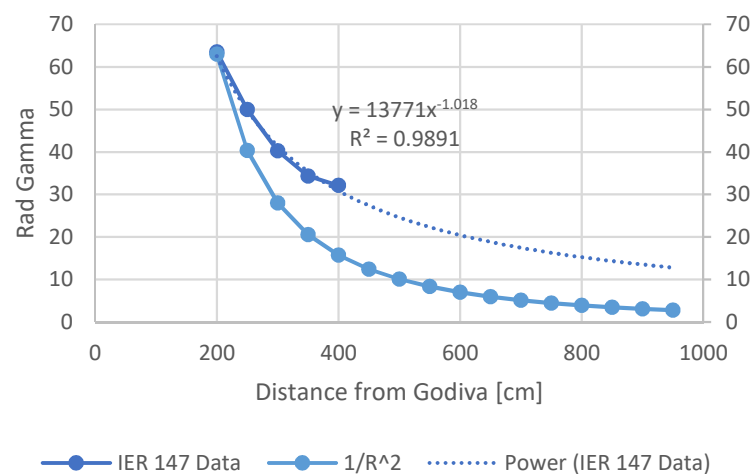
Neutron lifetime 1.19 E-6 s

\*historical references list values for max 525°C burst



# Dose rates

200 °C Gamma Dose (IER 147)



## Acknowledgements

**NCERC is supported by the DOE Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the Department of Energy.**

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**Research reported in this publication was supported by the U.S. Department of Energy LDRD program at Los Alamos National Laboratory.**



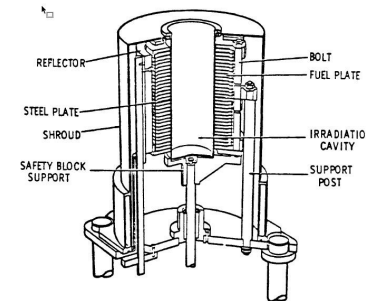
# Backup Slide



## SPR III – Sandia Pulsed Reactor



- The primary mission of the facility was to meet high neutron fluency or pulsed high dose requirements in the testing of electronic subsystems and components.
- Operated at Sandia from 1975-2000, then 2005-2006 for W-76 Life Extension Program and to generate data for QASPR. >10,000 operations
- The fuel was then sent to the Nevada Test Site.
- 258 kg, 93% enriched, U10Mo alloy
- ~6" (17 cm) diameter central cavity
- 6-8 MJ maximum burst
- $6.1 \times 10^{14}$  n/cm<sup>2</sup>
- $8 \times 10^{18}$  n/cm<sup>2</sup>-s



From Berry F. Estes & Jon A. Rauscher, *Results of the Initial Test Program for the Sandia Pulsed Reactor III (SPR III)*, Sandia Laboratories, 1976

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